



CS/B.TECH(N)/ODD/SEM-1/1004/2024-2025/1040

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Paper Code : BS-M101/BSM101 Mathematics -IA

UPID : 001004

Time Allotted : 3 Hours

Full Marks :70

The Figures in the margin indicate full marks.

Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

1. Answer any ten of the following :

[1 x 10 = 10]

- (i) $f(x)=|x|$ satisfies Roll's theorem $[-1,1]$. State true or false with reasons.
- (ii) Every square matrix A can be expressed as a sum of symmetric and skew symmetric matrix and it can be expressed as=
- (iii) Collection of vectors containing null vectors is linearly _____.
- (iv) The eigen value of the matrix A are a and b; then what are the eigen values of A^2 ?
- (v) The value of $\Gamma(5/2) = ?$
- (vi)

$$\lim_{x \rightarrow 0} \frac{1 - \cos x}{\sin x} = ?$$

(vii) Find the value of C for which the vector (1,2) and (3,C) linearly independent.

(viii) A set of vectors in a vector space V over a field F is orthogonal if $||\alpha|| = \underline{\hspace{2cm}}$.

(ix) What is eigen value of a square matrix?

Find the eigen value of the matrix $A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}$

(x) Define Beta and Gamma functions.

(xi) The product of two Orthogonal matrix is _____ matrix.

(xii) The product of any matrix and its transpose is _____ matrix.

Group-B (Short Answer Type Question)

Answer any three of the following :

[5 x 3 = 15]

1. Check whether the vectors $\{(1, 1, 0), (1, 1, 1), (0, 1, -1)\}$ is a basis in R^3 or not. [5]
2. State Lagrange's mean value theorem. [5]

Prove that $\frac{x}{1+x} < \log(1+x) < x, x > 0$

3. Solve the following equations by matrix inversion method, if possible: [5]
 $2x+3y+z=6; 3y+5z=8; -x+y=0$

4. Define subspace of a vector space. [5]

Let $V = \{M_2 \text{ set of all } 2 \times 2 \text{ matrices of the form } \begin{pmatrix} a & b \\ c & d \end{pmatrix}, a, b, c, d \in R\}$ and S is the subset of V such that $S = \{\begin{pmatrix} a & b \\ c & d \end{pmatrix} : a + b = 0\}$ is a subspace of V. Prove that S is a subspace of V.

5. Prove that $B(m, n) = B(n, m)$. Also write the relation between Beta and Gamma functions and find $B(3,4)$. [5]

Group-C (Long Answer Type Question)

Answer any three of the following :

[15 x 3 = 45]

1. (a) Define kernel of a linear transformation between two vector spaces. [5]
Is $f(x) = \sin x$ a Linear transformation? Justify your answer.
- (b) State Cayley Hamilton theorem for matrices. What is the Characteristic equation of a square matrix? Explain with an example. [4]
- (c) What is eigen vector? [6]

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Find the eigen values and eigen vectors of matrix $\begin{pmatrix} 2 & -1 \\ 1 & 4 \end{pmatrix}$.

8. Show that the set of all complex numbers is a vector space over real field w.r.t the usual addition between two complex number and multiplication between a real number and a complex number. Find a basis of this space and hence the dimension. [15]

9. What is diagonalization of matrix? [15]

Diagonalise the matrix $A = \begin{pmatrix} 6 & 4 & -2 \\ 4 & 12 & -4 \\ -2 & -4 & 13 \end{pmatrix}$. Write the matrix P, such that $P^{-1}AP$ is diagonal matrix. Also show that $P^{-1}AP = D$.

10. (a) Prove that $\int_0^{\infty} \frac{1}{(1+x^2)^3} dx = 35\pi/256$ [7]

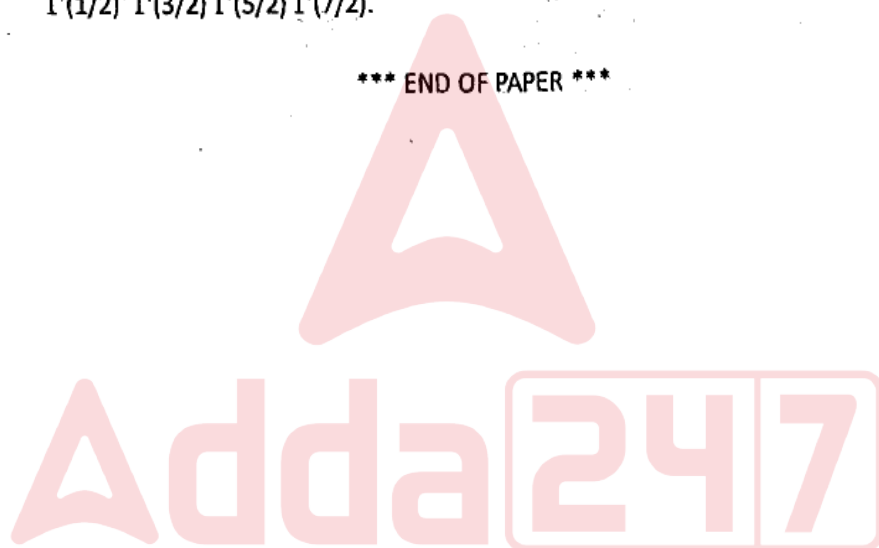
- (b) Obtain the evolute of the parabola $y^2 = 4ax$. [8]

11. (a) Verify Lagrange's MVT for $f(x) = x(x-1)(x-2)$ in $[0, 1/2]$. [5]

- (b) Expand the following functions in power of x in infinite series stating in each case the condition under which the expression is valid: $f(x) = \cos x$. [5]

- (c) Evaluate $\Gamma(1/2) \Gamma(3/2) \Gamma(5/2) \Gamma(7/2)$. [5]

*** END OF PAPER ***



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